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CANOTIA

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Canotia publishes botanical and mycological papers related to Arizona. These may include contributions to the Vascular Plants of Arizona project, checklists, local floras, new records for Arizona and ecological studies. All manuscripts are peer-reviewed by specialists. Acceptance for publication will be at the discretion of the editor. At least 30 printed copies of each issue are distributed to libraries in the United States, Europe, and Latin America. Anyone may download copies free of charge at http://lifesciences.asu.edu/herbarium/canotia.html.

Canotia is named for *Canotia holacantha* Torr. (Celastraceae), a spiny shrub or small tree nearly endemic to Arizona.

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ERICACEAE HEATH FAMILY

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Shrubs or small trees, pubescent or glabrous. LEAVES simple, evergreen or deciduous, alternate or rarely opposite, entire or toothed, usually petiolate, lacking stipules. INFLORESCENCES usually bracteate terminal racemes or corymbs, or solitary and axillary. FLOWERS usually perfect, actinomorphic or nearly so and hypogynous, usually pedicelate; sepals 4 or 5, distinct or shortly connate; petals 4 or 5, distinct or connate with short lobes; stamens alternate with petals, the anthers dehiscing by terminal pores, usually awnless or with awn-like appendages called spurs (*Arctostaphylos*, *Vaccinium*); pistil 1, the ovary mostly 4 or 5 locular with axile placentation, superior or sometimes inferior (*Vaccinium*); style 1; stigma 1, capitate. FRUITS usually berries or drupes, or sometimes capsules (*Phyllodoce*) with many seeds. $x = 12, 13$. —Ca. 100 genera and 3000 spp., worldwide, usually on acidic soils in temperate zones. Many species cultivated as ornamentals (e.g., *Rhododendron*, *Azalea*, and *Erica*) and for fruits (e.g., blueberries and cranberries - *Vaccinium*).

Only Ericaceae sensu strictu is treated here. Recent phylogenetic analysis of molecular and morphological data (Kron et al. 2002) supports the traditional classification of Ericaceae as including the Monotropaceae and Pyrolaceae, families previously treated in the *Vascular Plants of Arizona* (Haber 1992a; 1992b). When considered a single family, these groups are sometimes treated as subfamilies. For consistency, Ericaceae is treated apart from Monotropaceae and Pyrolaceae as a separate family in this flora.

1. Leaves thin, deciduous; ovary inferior; fruit a juicy berry ..... ***Vaccinium***
1' Leaves leathery, evergreen; ovary superior; fruit fleshy, mealy, or a capsule 2
   2. Heath-like shrubs with needle-like leaves; corolla campanulate; anthers awn-less; fruit a capsule ..... ***Phyllodoce***
   2' Shrubs or trees with broad, flat leaves; corolla urceolate; anthers awned; fruit a berry or drupe 3
      3. Trees of southeastern Arizona; fruit a berry with papillate surface ..... ***Arbutus***
      3' Shrubs widespread; fruit a berry-like drupe with smooth surface ... ***Arctostaphylos***

Arbutus L. Madrone

Trees to 15 m tall, or sometimes shrubs, with checkered or smooth reddish bark. LEAVES simple, alternate, evergreen; blades leathery; margin serrate to entire; petioles reddish; stipules absent. INFLORESCENCES terminal racemes or few-branched panicles with ovate bracts. FLOWERS perfect, actinomorphic; sepals 5-lobed; corolla white to pinkish, bell-shaped or urceolate; stamens 10, included;

filaments from a swollen base and nectary disc, dilated, hairy at base; anthers awned; ovary superior; style simple, columnar, capitate. FRUITS berries, pappillose-roughened, with 15–25 seeds. —Ca. 20 spp. in N. Amer., C. Amer., and w Eur. (Latin name for *A. unedo*, strawberry tree).

Arbutus arizonica (A. Gray) Sarg. (of Arizona). Arizona Madrone. —Trees and sometimes shrubs; trunks with checkered gray bark; branches with smooth reddish bark. LEAVES lanceolate to elliptic, 5–12 cm long, 1.5–3.5 cm wide; blades light green, glossy above, pale green below, glabrous; bases rounded to cuneate; tips acute to rounded. FLOWERS pedicellate; sepals 2–2.5 mm long, lobed with membranous margins; corollas 6–8 mm long. FRUITS 8–10 mm in diameter, semi-fleshy, orange, edible (Fig. 2A). —Canyon bottoms and hillsides in oak-pine zone: Cochise, Graham, Pima and Santa Cruz cos. (Fig. 1A); 1200–2500 m (4000–8200 ft.); May–Jun; se AZ and sw NM to Jal. and S.L.P., Mex.

Arctostaphylos Adans. Manzanita, Bearberry

Shrubs erect or prostate and mat-forming; bark usually reddish-brown, smooth. LEAVES simple, evergreen, leathery; margins usually entire. INFLORESCENCES terminal simple or few-branched racemes or dense panicles. FLOWERS perfect, actinomorphic; sepals imbricate and distinct; corollas white to pink; stamens 10, included; anthers spurred; filaments dilated, hairy. FRUITS berry-like drupes, fleshy. —50–60 spp., mostly N. Amer., one circumboreal. (Greek *arctos*, bear, and *staphyle*, a bunch of grapes, fruits of *A. uva-ursi* eaten by bears).

1. Shrubs low, creeping and mat-forming, less than 1 m tall; leaves spatulate .... ***A. uva-ursi***
1' Shrubs erect, usually more than 1 m tall; leaves elliptic to ovate 2
  2. Calyx, pedicels, and new twigs pilose, with glandular, spreading hairs ..... ***A. pringlei***
  2' Calyx, pedicels, and new twigs puberulent to glabrous 3
    3. Axis of the inflorescence finely glandular puberulent to subglabrous; inflorescence a panicle ..... ***A. patula***
    3' Axis of the inflorescence densely white puberulent; inflorescence a raceme ..... ***A. pungens***

Arctostaphylos patula Greene (outspread, referring to the branches). Greenleaf Manzanita. —Shrubs with rigid, spreading branches, the lower ones rooting and forming low thickets, (0.3) 1–2 m tall; bark reddish brown, smooth; branchlets glandular pubescent. LEAVES mostly orbicular to narrowly elliptic; blades 1.2–4 cm long, 1.5–4 cm wide, bright green, shiny, glabrous; bases rounded to truncate; tips obtuse to acute; petioles 7–15 mm long, pubescent (Fig. 3). INFLORESCENCES dense panicles, glandular puberulent to subglabrous; bracts acuminate, 1–4 mm long. FLOWERS 5–8 mm long; sepals with ovate lobes 2 mm long, glabrous; corollas white to pink, urceolate; pedicels 2–8 mm long, glabrous; ovary glabrous. FRUITS depressed globose, 8–12 mm wide, dull orange to brown, glabrous. $2n = 26$. [*A. platyphylla* (A. Gray) Kuntze, *A. pungens* Kunth var. *platyphylla* A. Gray, *A. parryana* Lemmon var. *pinetorum* (Rollins) Wiesl. & B.

Schreib., *A. pinetorum* Rollins]. —Open forests, often in ponderosa pine savannah, pinyon-juniper woodlands: Coconino, Mohave, and Navajo cos. (Fig. 1A); 1900–2700 m (6300–8900 ft); Mar–Jul; n AZ, Baja C. Norte to WA, e to MT, CO.

Arctostaphylos pringlei Parry (after C.G. Pringle). Pringle Manzanita. —Shrub, 0.2–0.5 m tall; bark reddish brown, smooth; branchlets densely glandular hairy. LEAVES lance-elliptic to ovate; 2–5 cm long, 1–3 cm wide, gray green, glaucous to finely glandular; bases rounded to truncate; tips obtuse to acute; margins entire; petioles 5–10 mm long, glandular hairy (Fig. 3). INFLORESCENCES simple or one-branched racemes, densely glandular hairy; bracts 6–10 mm long, lanceolate, acuminate, pink (Fig. 4A). FLOWERS 6–9 mm long, finely glandular hairy; sepals narrowly lanceolate, glandular hairy; corollas pink to white, urceolate; pedicels 5–10 mm long, glandular-pubescent; ovaries glandular hairy. FRUITS ovoid to globose, 6–10 mm wide, red (Fig. 2B). $2n = 26$. —Dry, rocky hills with interior chaparral and pinyon-juniper and cypress woodlands: all cos. except Apache, La Paz, and Yuma (Fig. 1B); 1200–2000 m (4000–6600 ft.); Apr–May; s CA, n Baja C. to s NV, sw UT.

Arctostaphylos pungens Kunth (terminating in a sharp point). Point-leaf Manzanita, Mexican Manzanita. —Shrubs with rigid, spreading branches, 1–2 m tall; bark reddish brown, smooth; branchlets densely pubescent. LEAVES elliptic to lance-elliptic; blades 1.5–4 cm long, 0.5–2 cm wide, pale green, lustrous, glabrous; bases acute to rounded; tips acute and mucronate; margins entire (young leaves may be toothed); petioles 4–9 mm long, white-puberulent (Fig. 3). INFLORESCENCES simple or few-branched racemes, densely white puberulent; bracts acuminate, 1.5–4 mm long (Fig. 4B). FLOWERS 2–8 mm long; sepals with ovate lobes, reflexed, 1–2 mm long, glabrous; corollas white to pink, urceolate; pedicels 2.5–6.5 mm long, glabrous; ovaries glabrous. FRUITS depressed-globose, 5–11 mm wide, orange to brownish-red, glabrous. $2n = 26$. —Rocky hillsides with interior chaparral and openings in ponderosa pine savannah: all cos. except Apache, La Paz, and Yuma (Fig. 1C); 1000–2500 m (3300–8200 ft); Feb–Jun; Mex. and TX, n to NV, UT.

Arctostaphylos uva-ursi (L.) Spreng. (bear-grape). Bearberry, kinnikinnik. —Prostrate shrubs, 0.1–0.2 m tall, with branches trailing along the ground, rooting and forming mats; branchlets glabrous to puberulent. LEAVES oblanceolate to obovate; blades 1–2.5 cm long, 0.3–1 cm wide, dark green above, light green below, glabrous; bases wedge-shaped; tips rounded, not mucronate; margins entire; petiolate 2–5 mm long, glandular (Fig. 3). INFLORESCENCES simple or few-branched racemes, densely puberulent; bracts acuminate, 1.5–4 mm long. FLOWERS 4.5–8 mm long; sepals with reflexed lobes, 1–2 mm long; corollas white to pink, 4.5–8 mm long, urceolate; ovaries glabrous. FRUITS depressed globose, 6–12 mm wide, bright red, glabrous. $2n = 26$. [*A. uva-ursi* var. *adenotricha* Fernald & J. F. Macbr., *A. adenotricha* (Fernald & J. F. Macbr.) A. Löve, D. Löve, & B. M. Kapoor, *Arbutus uva-ursi* L.]. —Ground cover under coniferous forests in dry to moist sites: Apache Co. (Fig. 1B); 2300–3000 m (7600–9900 ft); May–Aug; Lukachukai Mts in AZ, circumboreal.

Phyllodoce Salisbury Mountain Heather

Shrubs densely branched, evergreen; branches glandular-glabrous. LEAVES linear, needlelike, revolute, leathery, crowded and sessile. INFLORESCENCES terminal umbellate racemes. FLOWERS perfect, actinomorphic; sepals 5-lobed; corollas bell to urceolate, 5-lobed; pedicels bracteate; stamens 10; anthers elongate, awnless; ovaries superior, 5-celled; styles filiform, capitate. FRUITS septicidal capsules with many seeds. —Ca. 7 spp., circumboreal. (Greek: a sea nymph).

Phyllodoce empetriformis (Smith) D. Don (similar to *Empetrum*; Fig. 5). Red Mountain Heather. —Shrubs, low, mat forming, decumbent and rooting. LEAVES 6–12 mm long. FLOWERS sepals less than 2.5 mm long; corollas 5–9 mm long, red to rose colored; pedicels 1–2.5 mm long. FRUITS 3–4 mm in diameter, globose. $2n = 24$. —Known in AZ only from one historical collection (June, 1928) from the Grand Canyon, Yaki (South Kaibab) Trail (*McKee 1108* US). It was not relocated in a 1984 search (Phillips et al.1987). Subalpine meadows (typically): Coconino Co. (Fig. 1D); 1500–2700 m (5000–8900 ft.); Jul–Aug; AK to Alberta, Can., s to CA, CO. This plant may be extinct in Arizona; therefore, field botanists working in the state are urged to report on individuals or populations if located.

Vaccinium L. Blueberry

Shrubs openly branched. LEAVES deciduous, alternate; margins entire or serrulate, short petiolate. INFLORESCENSES solitary in leaf axils. FLOWERS perfect, actinomorphic; sepals 5-lobed or fused, glabrous; corollas shallowly 5-lobed, white to pinkish, pedicellate; stamens 10, usually included at the base of the corolla; anthers dehiscing terminally, with a pair of spurs; ovaries inferior, 5-celled; styles slender. FRUITS berries with many seeds. —400 spp., worldwide, temperate, subtropical and tropical montane regions. (Latin: *bacca* for berry).

Vaccinium myrtillus L. (little myrtle; Fig. 6). Blueberry, whortleberry. —Shrubs openly branching and forming open colonies from woody rhizomes, 10–40 cm tall; branches bright green, glabrous, sharply angled, flexuous. LEAVES simple, ovate to elliptic, 1–4 cm long, 7–16 mm wide, thin, glabrous or with scattered glandular hairs; tips acute. INFLORESCENCES solitary in leaf axils of current year's growth. FLOWERS 2–4 mm long; sepals glabrous, the lobes none to obscure; corollas white or pink; filaments glabrous; anthers awned. FRUITS berries, 5–9 mm wide, blue or blue-black. $2n = 24, 48$. [*V. myrtillus* var. *oreophilum* (Rydb.) Dorn, *V. oreophilum* Rydb.]. —Mixed coniferous and spruce-fir forest, hillsides, openings: Apache, Cochise, Coconino, Graham cos. (Fig. 1D); 2400–3400 m (7900–11,000 ft); Jun–Jul; se AZ and NM, n to Can., temperate Northern Hemisphere.

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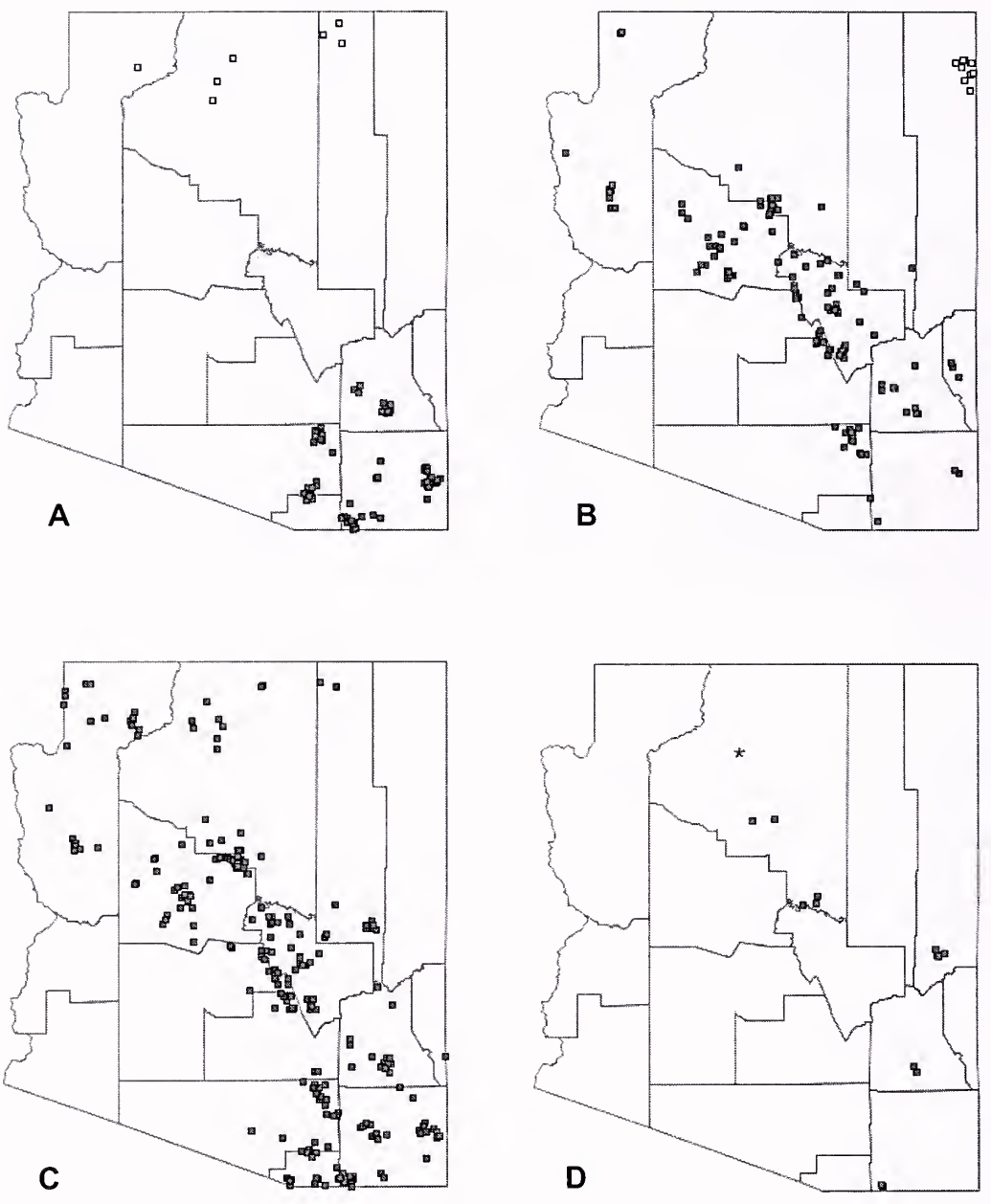
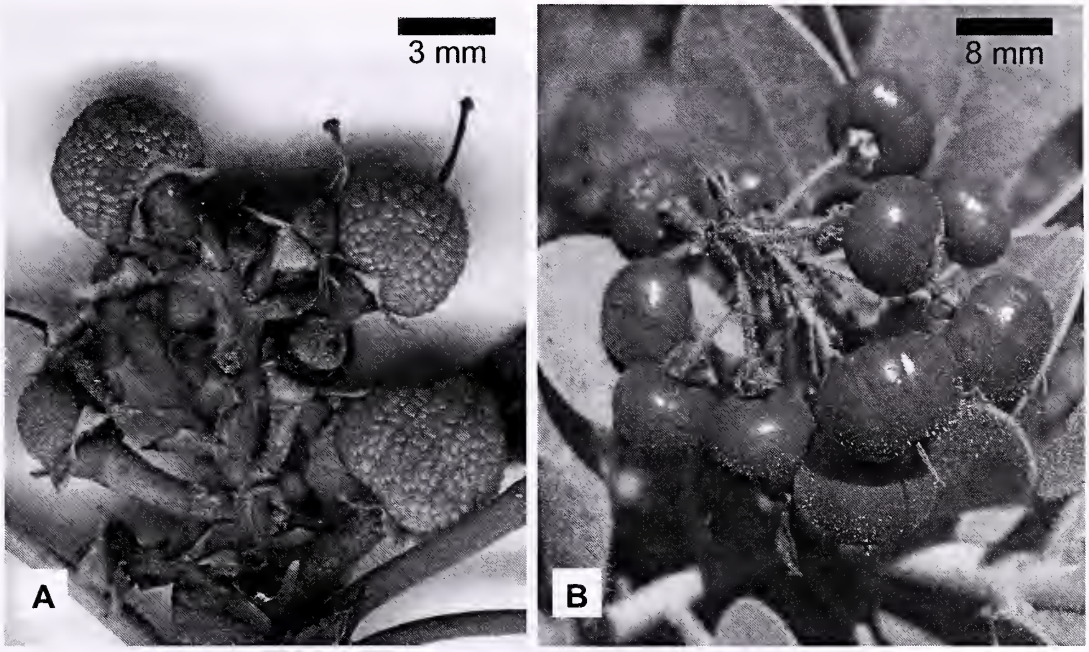
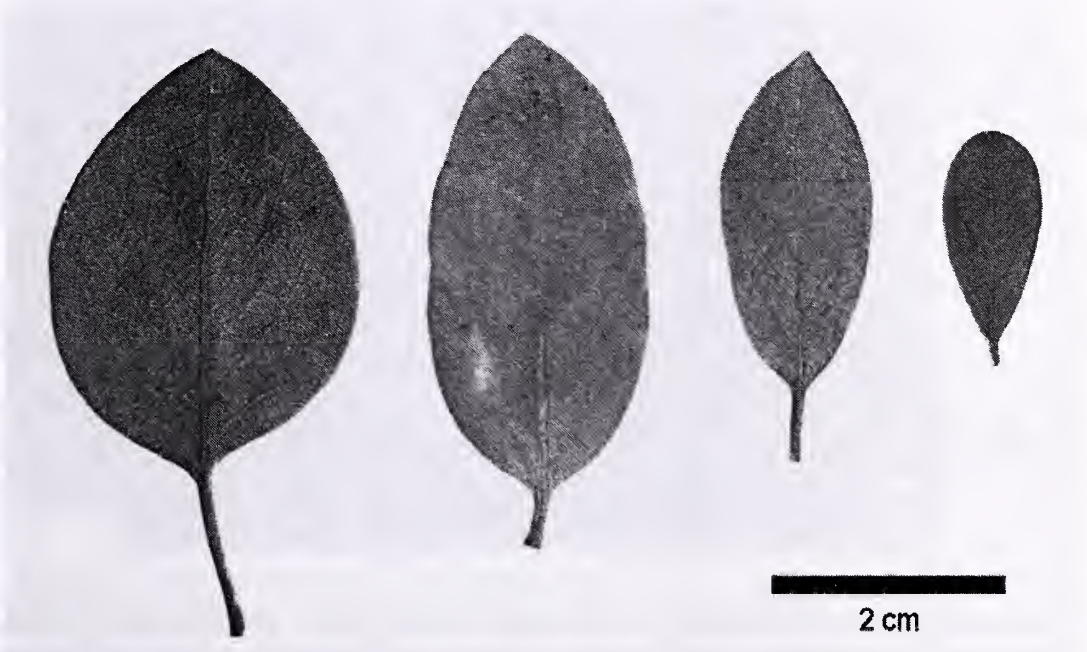


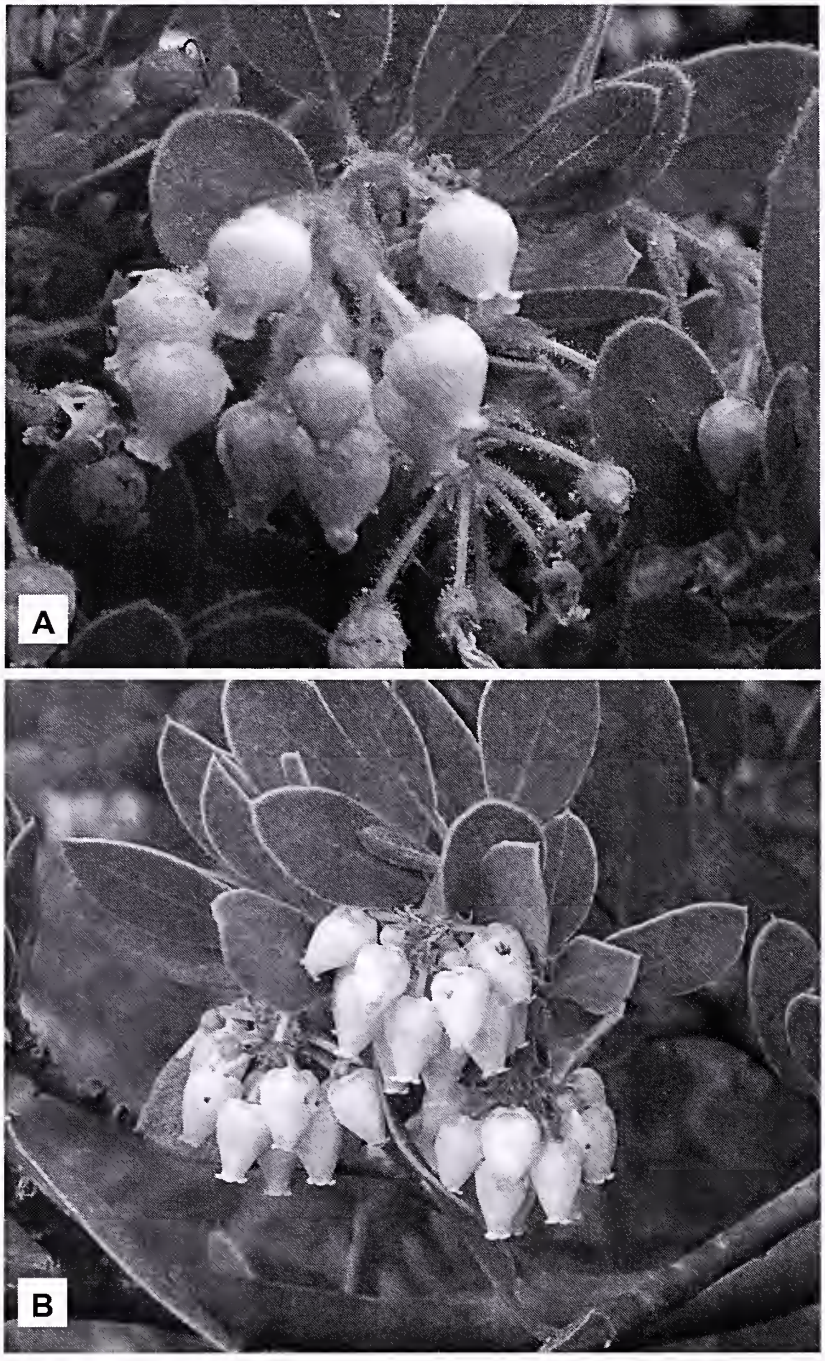
Ericaceae Figure 1. Distributions of: (A) *Arbutus arizonica* (solid squares) and *Arctostaphylos patula* (open squares); (B) *Arctostaphylos pringlei* (solid squares) and *Arctostaphylos uva-ursi* (open squares); (C) *Arctostaphylos pungens*; (D) *Phyllodoce empetriformis* (asterisk) and *Vaccinium myrtillus* (solid squares).



Ericaceae Figure 2. Comparison of fruits: (A) *Arbutus arizonica* (berry with a papillate surface); (B) *Arctostaphylos pringlei* (berry-like drupe with a smooth surface) - (*images courtesy of L.R. Landrum*).



Ericaceae Figure 3. Comparison of *Arctostaphylos* leaves (from left to right): *A. patula* (*Halvorson 304*, ASU); *A. pringlei* (*Lehto et al. 11276*, ASU); *A. pungens* (*Landrum 5115*, ASU); *A. uva-ursi* (*Reeves 8193*, ASU) - (*image courtesy of S.T. Bates and L.R. Landrum*).



Ericaceae Figure 4. Comparison of *Arctostaphylos* inflorescences: (A) *A. pringlei* (note the glandular hairs, particularly visible on the flower pedicels and leaf petioles, and the nearly obtuse leaf tips); (B) *A. pungens* (note the glabrous to puberulent flower pedicels and leaf petioles as well as the acute mucronate leaf tips) - (*image courtesy of M. Licher*).

Ericaceae Figure 5. *Phyllodoce empetriformis* (*Cooke et al. 2396, Olympic National Park, Clallam Co., Washington*, ASU) - (*image courtesy of S.T. Bates and L.R. Landrum*).

Ericaceae Figure 6. *Vaccinium myrtillus*: (A) flowering branch; (B) leaf; (C) pistil and calyx; (D) corolla; (E) flower after removal of corolla (showing stamens with appendages) - (*image: 'Plate 39', drawn by C. F. Newall in* Trees and Shrubs of the British Isles, native and acclimatised, *by C. S. Cooper and W. P. Westell, published by E. P. Dutton & Co., New York, 1909*).

AZOLLACEAE MOSQUITO FERN FAMILY

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Annual or perennial floating aquatic herbs, sometimes stranded on mud, heterosporous. ROOTS adventitious, appearing fascicled from the stem nodes, unbranched. STEMS more or less dichotomously branched, sometimes breaking apart with age. LEAVES alternate, 2-ranked, slightly overlapping, sessile, deeply 2-lobed, the lobes lacking apparent venation, one lobe floating and green, the other submerged, translucent, and nonphotosynthetic. FLOATING LEAF LOBES oblong-ovate to obovate, the adaxial (emergent) surface with moderate to dense, minute, papilla-like hairs, with narrow thin entire margins. SUBMERSED LEAF LOBES slightly larger than the floating lobes, oblong-ovate to obovate, thin, membranous. SORI borne in sporocarps. SPOROCARPS of 2 types, usually on the same plant, globose or nearly so, each containing 1 sorus, some with 1 megasporangium containing 1 megaspore, others with numerous microsporangia, each containing 32 or 64 microspores, produced infrequently, in pairs on short submerged stem branches (Fig. 2). SPORANGIA thin-walled, lacking an annulus, breaking open irregularly through decay. MEGASPORES large (0.2–0.6 mm), more or less ovoid, differentiated into a basal hemispheric portion, a medial ring-like collar, and 3 apical sac-like floats, these covered by a more or less conical, cap (the remains of an indusium). MICROSPORES dust-like (10–27 μm), trilete, globose, imbedded in 3 or 4 amorphous translucent masses of cells (massulae), these with the outer surface usually bearing apically barbed trichomes. GAMETOPHYTES reduced, developing inside the spores, the archegonia and antheridia protruding from the spore wall. X = 22. —1 genus, ca. 7 spp., nearly worldwide.

Azolla Lam. Mosquito Fern

Characters of the family. (Greek for "to dry" and "to kill").

The megaspores of *Azolla* species are structurally the most complex of any fern and have an extensive fossil record dating back to the Cretaceous Era. This complex morphology involving differentiation of floats and an indusial cap, as well as the

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barbed microsporangial massulae, presumably is adaptive in bringing the spore types into proximity after their release into the aquatic environment. However, spores are produced only rarely, and spread is more often accomplished by fragmentation of stems and dispersal of plants by waterfowl or other vectors.

Classification of species in the genus depends heavily on megaspore morphology, as well as that of the trichomes on the floating leaf lobes and the barbs covering the massulae. The ca. 5 New World species are included in section *Azolla* and differ from the Old World section *Rhizosperma* (Meyen) Mett. in having apparently dichotomous (vs. pinnate) stem branching, megaspores with three (vs. 9) floats, and barbed (vs. acicular or no) trichomes on the microsporangial massulae. One member of sect. *Rhizosperma*, *A. pinnata* R. Br., is considered a noxious weed in the United States and appears sporadically as a contaminant in commercially grown aquatic plants imported from other regions. It has not been documented yet as an escape in Arizona, but may eventually be found. In addition to the spore and sporangial characters mentioned above, *A. pinnata* is also notable for the pinnate (vs. more or less dichotomous) branching pattern of its stems.

Azolla is the most important fern genus in world agriculture. For centuries, farmers in southeastern Asia added *A. pinnata* to rice paddies after the rice was planted as a kind of fertilizer. *Azolla* plants have chambers in the floating leaf lobes that contain a symbiotic filamentous cyanobacterium, *Anabaena azollae* Strasb. The bacteria are capable of fixing atmospheric nitrogen into a nitrate form that can be utilized by other plants as a fertilizer when released from decaying *Azolla* plant remains. Recently, efficient, fast-growing strains of *A. filiculoides* have been among those developed for this purpose.

Azolla filiculoides Lam. (diminutive, fern-like). Western Mosquito Fern. —PLANTS 0.7–3.0 cm long, sometimes to 5 cm in cultivation (Fig. 3). STEMS glabrous. FLOATING LEAF LOBES 0.5–0.8 mm long, somewhat convex, usually with hyaline or reddish margins (turning entirely dull reddish brown in the autumn), the minute adaxial trichomes 1-celled. MEGASPORES with the hemispherical portion having irregularly confluent, angular papillae, sometimes appearing irregularly pitted, also sparsely to moderately tomentose with long, loosely curled trichomes; the collar somewhat concave, glabrous, the cap appearing fibrous. GLOCHIDIA with an average of 3–5 crosswalls. $2n = 44, 66$. —Ponds, lakes, and backwaters of rivers, in still or sluggish water, sometimes stranded on mud: Cochise, Coconino, Graham, Greenlee, La Paz, Maricopa, Mohave, Pima, Pinal, Santa Cruz cos. (Fig. 1; also reported, but not vouchered, from Yuma Co.); 600–1200 m (2000–4000 ft); WA to CA and AZ, w Can., Mex., s to S. Amer.; introduced in HI and the Old World.

Populations of *A. filiculoides* in Arizona are uncommon and sporadic. Waterfowl move the plants around and eventually it may be discovered at other sites in the state.

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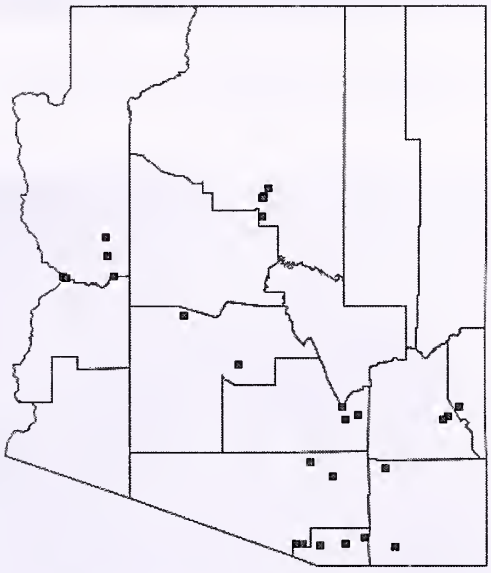
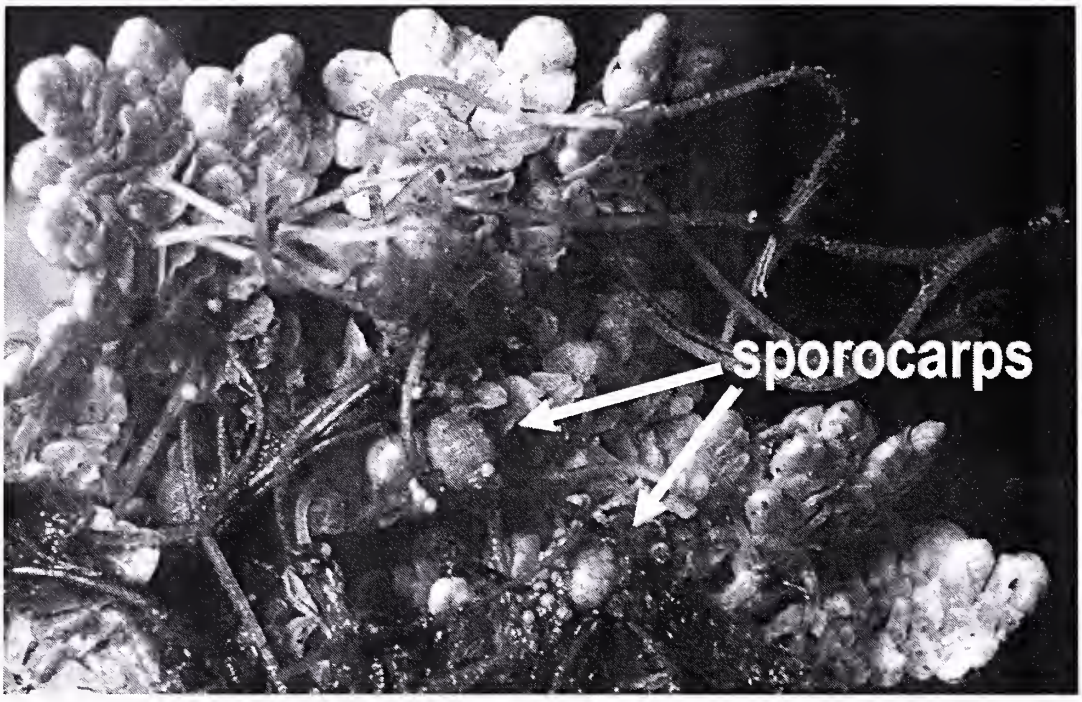


Azollaceae Figure 1. Distribution of: *Azolla filiculoides.*



Azollaceae Figure 2. *Azolla filiculoides*, closeup of abaxial side with microsporocarps.

Azollaceae Figure 3. *Azolla filiculoides,* group of plants adaxial side.

BLECHNACEAE CHAIN FERN FAMILY

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Perennial herbs with branched or unbranched rhizomes, these scaly, the scales not clathrate. ROOTS adventitious, usually branched. AERIAL STEMS absent. LEAVES narrowly or widely spaced along the rhizome, ours monomorphic (dimorphic elsewhere), the vernation circinate. BLADES variously pinnately compound, herbaceous to somewhat papery or leathery in texture, usually sparsely scaly and with minute glandular trichomes when young, glabrous or nearly so at maturity, the developing leaves often reddish- or purplish-tinged. VENATION with a single series of elongate areoles parallel to the costa, otherwise usually free, the veinlets irregularly and/or dichotomously branched. SORI on the abaxial leaf surface, surficial or more commonly from shallow pits in the blade surface, ours discrete (confluent elsewhere), restricted to the costal areoles, narrowly oblong to linear in outline. INDUSIA narrowly oblong, attached under the sorus but appearing lateral, opening along the side opposite the costa. PARAPHYSES absent. SPORANGIA with a stalk usually 3 cells wide, the capsule with a vertical ring-like annulus, glabrous. SPORES usually 64 per sporangium, monomorphic, monolete, bean-shaped, usually brown. GAMETOPHYTES surficial, cordate, green, sometimes glandular, potentially bisexual. —Ca. 10 genera and 250 spp., nearly worldwide.

Woodwardia Sm. Chain Fern

RHIZOMES moderately stout, compact to short-creeping in ours, densely scaly toward the tip, the scales concolorous. LEAVES closely spaced and evergreen in ours. PETIOLES usually shorter than the blade, usually grooved adaxially. BLADES somewhat papery or leathery, ovate to elliptic-ovate, mostly pinnate-pinnatifid. PINNAE acuminate at the tip, with numerous lobes, the margins otherwise serrulate, glabrous at maturity. SORI forming a chain-like row on either side of the costa. INDUSIA papery, more or less persistent. X = 34. —Ca. 14 spp., Can. s to C. Amer., Eur., Asia. (for Thomas J. Woodward, British botanist).

Vascular Plants of Arizona: Blechnaceae. *CANOTIA* 4 (2): 35–37, 2008.
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Woodwardia fimbriata Sm. (fringed). Giant Chain Fern. —RHIZOMES stout, forming a short ascending caudex, usually unbranched, the scales 10–30 mm long, lanceolate, acuminate at the the tip, monomorphic, light brown, somewhat shiny, the margins entire or nearly so. LEAVES densely clustered at the rhizome apex, 40–170 cm long (Fig. 3). PETIOLES straw-colored, brown at the base, glabrous distally, thickened and densely scaly at the persistent base, the scales 5–25 mm long, lanceolate, orangish brown. RACHISES similar to petioles, straw colored to green, glabrous. BLADES 15–45 cm wide, broadly elliptic-lanceolate, pinnate-pinnatifid proximally grading to pinnatifid distally, with usually numerous lateral pinnae, the basal few pairs of pinnae somewhat reduced. PINNAE mostly 8–40 cm long, 2.5–8.0 mm wide, with numerous deep lobes (Fig. 2). LOBES with minute glandular trichomes, especially adaxially, when young, glabrous at maturity, the margins mostly minutely serrulate. SORI sunken into relatively deep pits in the blade surface, narrowly oblong. INDUSIA thick-papery, persistent, glabrous. SPORES 57–68 μm long, the surface rugose, dark brown. $2n = 68$. —Mesic canyon bottoms, usually among boulders along streams: Gila, Graham, Maricopa, Pima, Santa Cruz cos. (Fig. 1); 1550–2200 m (5000–7000 ft). WA, OR, CA, NV, AZ, sw Can., nw Mex.

We were unable to substantiate Morton's (in Kearney and Peebles 1960) report of this species from Apache and Cochise Counties.

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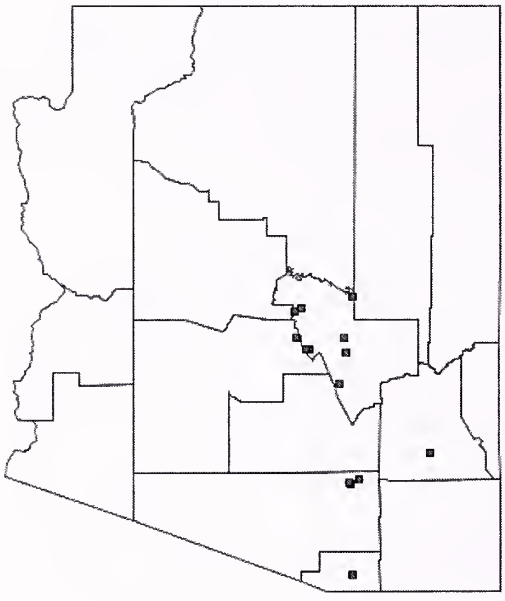
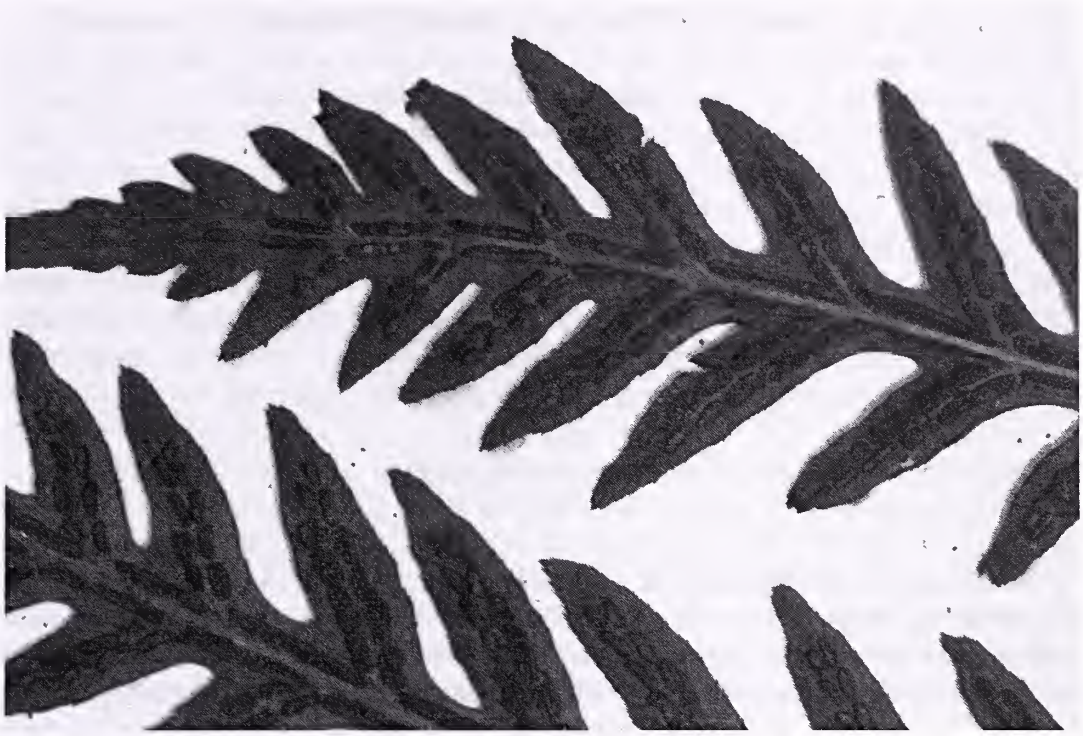


Blechnaceae Figure 1. Distribution of: *Woodwardia fimbriata.*



Blechnaceae Figure 2. *Woodwardia fimbriata*, pinnae.

Blechnaceae Figure 3. *Woodwardia fimbriata*, leaves.

DENNSTAEDTIACEAE BRACKEN FAMILY

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Perennial herbs with usually branched rhizomes, these hairy in ours. ROOTS adventitious, usually branched. AERIAL STEMS absent. LEAVES narrowly or widely spaced along the rhizome, monomorphic or nearly so, the vernation circinate. BLADES variously pinnately compound, herbaceous to somewhat papery or leathery in texture, variously glabrous to hairy. VENATION free or fused along the margins, the veinlets unbranched or udichotomosly few-branched. SORI on the abaxial leaf surface, surficial, confluent, forming a line along the margins in ours. INDUSIA usually present, sometimes poorly developed, the recurved pinna margins sometimes also acting as a pseudoindusium. PARAPHYSES absent. SPORANGIA with a stalk 1–3 cells wide, with a vertical ring-like annulus, glabrous. SPORES usually 64 per sporangium, monomorphic, trilete in ours, tetrahedral-globose, usually brown. GAMETOPHYTES surficial, cordate, green, sometimes glandular, potentially bisexual. —Ca. 20 genera and 400 spp., nearly worldwide.

Pteridium Gled. ex Scop. Bracken

Colonial perennial herbs. RHIZOMES moderately stout, deep-seated, very long-creeping, densely pubescent with multicellular hairs. LEAVES widely spaced, deciduous. PETIOLES shorter than to about as long as the blade, grooved adaxially. BLADES somewhat papery or leathery, broadly deltate, 2–4 times pinnately compound. PINNAE pinnatifid, acuminate at the tip, with numerous lobes, variously pubescent. SORI forming a more or less uninterrupted submarginal line. INDUSIA of 2 types, curled pinnae margins forming pseudoindusia opposed to excurrent true indusia, these linear, often poorly developed. X = 52. —5 spp., nearly worldwide. (Greek for "small fern").

The treatment here follows the recent classification of *Pteridium* to comprise 5 species, with a number of additional infraspecific taxa (Thomson et al. 2008). Many previous authors have followed Tryon's (1941) treatment of a single species with a dozen infraspecific taxa.

Vascular Plants of Arizona: Dennstaedtiaceae. *CANOTIA* 4 (2): 38–40, 2008.
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Pteridium aquilinum (L.) Kuhn (eagle-like). Bracken. —LEAVES widely spaced along the rhizome, 0.4–3.5 m long. PETIOLES straw-colored, hairy at least proximally. RACHISES similar to petioles, straw colored to green, glabrous or hairy. BLADES 15–100 cm wide, broadly deltate, mostly 3-pinnate-pinnatifid, with usually 14 or fewer main lateral pinnae, these often opposite or nearly so along the rachis, the basal few pairs of pinnae longer basiscopically than acroscopically. PINNAE 7–50 cm long, mostly 2–5 times as long as wide, the pinnules with numerous deep lobes, sparsely to densely hairy, at least abaxially (Fig. 2A). LOBES with the margins entire or inconspicuously crenulate. PSEUDOINDUSIA differentiated from the rest of the blade, pale or whitened, glabrous or hairy. SPORES 25–40 μm long, the surface finely granulate, dark brown. $2n = 104$. —Nearly worldwide.

Bracken is found on every continent except Antarctica and generally is considered one of the world's worst weeds, which render range land unsuitable for grazing. Toxins contained in the leaves inhibit the growth of other plant species, and the species has been shown to interfere with the regeneration of trees and shrubs following fires or logging in the western United States. Although the developing fiddleheads have been harvested for human consumption, the leaves also contain a number of nerve toxins, as well as carcinogenic and mutagenic compounds, that are poisonous to both livestock and humans when ingested.

Subsp. **pubescens** (Underw.) J.A. Thomson, Mickel & Mehltreter (hairy). Western Bracken (Fig. 2B). —PINNULES positioned nearly 90 degrees from the costa, both surfaces moderately to densely pubescent with lax contorted hairs, the adaxial surface usually glabrescent at maturity. PSEUDOINDUSIA hairy on the surface and margin. —Montane woodlands and forests, especially pine forests, occasionally stream banks, open lava, or roadsides: Apache, Cochise, Coconino, Gila, Graham, Greenlee, Navajo, Pima, Yavapai cos (Fig. 1); 1180–2900 m (3900–9500 ft); w U.S. east to MT and TX, w Can., nw Mex.

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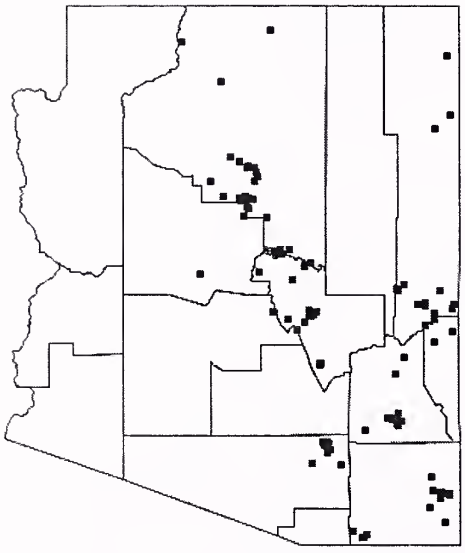
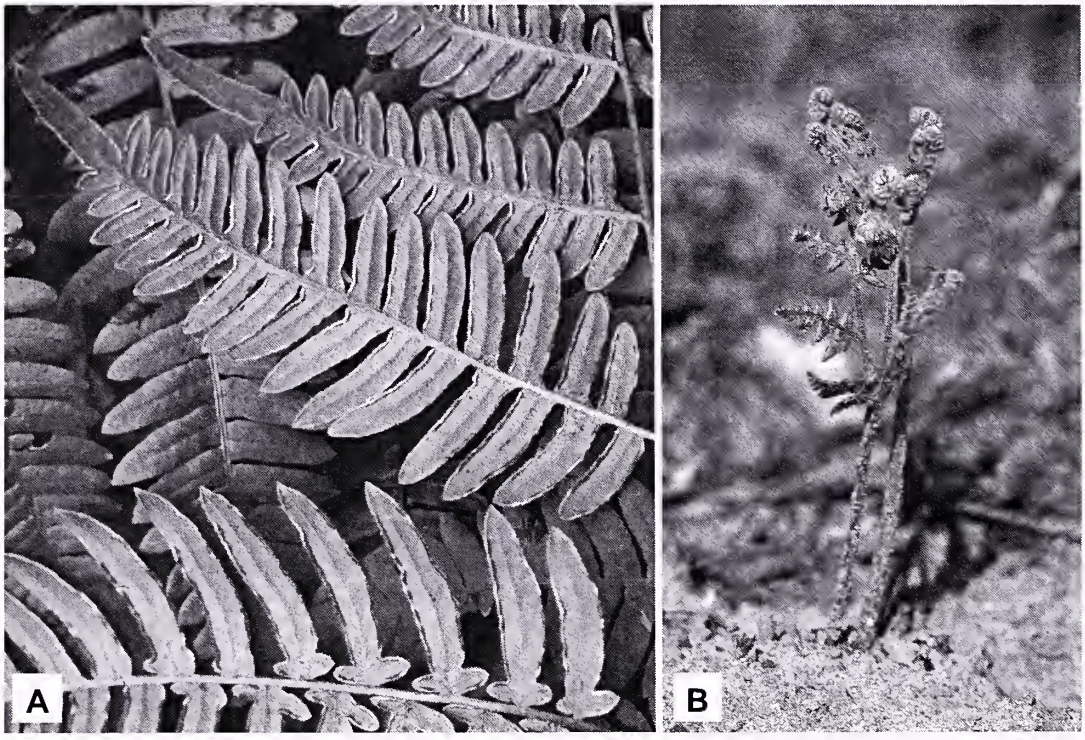


Dennstaedtiaceae Figure 1. Distribution of: *Pteridium aquilinum* subsp. *pubescens.*



Dennstaedtiaceae Figure 2. *Pteridium aquilinum* subsp. *pubescens*: (A) pinnae; (B) crozier.

EQUISETACEAE HORSETAIL FAMILY

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Perennial herbs with branched rhizomes. RHIZOMES deep-seated, often dark brown to purplish black, usually with nodal sheathes similar to the aerial stems, these becoming degraded with age. ROOTS adventitious, often branched. AERIAL STEMS unbranched or with whorls of branches, sometimes irregularly branched following flood damage, hollow (except at nodes), with a larger central longitudinal canal and 2 rings of smaller canals, those under the ridges (carinal canals) and those between the ridges (vallecular canals). the nodes jointed. LEAVES whorled, fused into short sheaths at the stem nodes, the tooth-like free tips brown to black, concolorous or bicolorous with a green to white midvein or white margins, persistent or shed early. STROBILI cone-like, with peltate sporophylls, borne at the stem and/or branch tips, green or the sporangiophores sometimes brownish- to blackish-tinged, the strobilus tip rounded or sharply mucronate. SPORANGIA in a ring of 5-10 along the undersurface of sporophylls, saclike, dehiscing by a lateral slit. SPORES monomorphic, globose, green, bearing 4 linear-spatulate, white structures (elaters). GAMETOPHYTES surficial, irregularly disk-shaped, green, usually functionally unisexual. —1 genus, 15 spp., nearly worldwide.

The strobili of *Equisetum* are complex structures. The highly modified sporophylls are tightly spiraled and oriented at right angles to the central axis. The outer surface of the strobilus appears as a series of interlocking hexagonal plates, which separate at maturity through elongation of the central axis. The mass of spores appears as minute green globes (visible with a hand lens) immersed in a cottony mass of elaters. The elaters spread as they dry and coil around the spores when wetted. This complex reproductive morphology notwithstanding, much of the reproduction in *Equisetum* species is vegetative from rhizome and aerial stem fragments dispersed by flood-waters or perhaps in mud on the feet and feathers of waterfowl.

Equisetum L. Horsetail, Scouring-rush

Characters of the family. (Latin for "horse" and "bristle" [for the course dark roots]).

Vascular Plants of Arizona: Equisetaceae. *CANOTIA* 4 (2): 41–45, 2008.
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Heil and O'Kane (2003) reported *E. pratense* Ehrh. from Apache County (and also from Colorado, New Mexico, and Utah) without supporting data. Steve O'Kane (pers. comm.) was unable to locate any voucher specimens documenting this report and for the present the species is excluded from the Arizona flora. *Equisetum pratense* differs from the closely related *E. arvense* in its fertile stems, which become green and branched after the spores have been shed and in its cuneate rather than attenuate sheath teeth. It is a northern taxon otherwise unknown from the southwestern United States.

Heil and O'Kane (2003) also reported *E. variegatum* Schleich. ex F. Weber & D. Mohr as occurring in Apache and Navajo Counties. Because voucher specimens have not been discovered, this taxon is similarly excluded. *Equisetum variegatum* produces persistent unbranched stems that are usually less than 50 cm tall and have apically banded sheaths with persistent teeth. The stems differ from those of *E. hyemale* and *E. laevigatum* in having only 3–12 ridges. In those species, depauperate plants or those regenerating following floods or wounding might be mistaken for *E. variegatum*. *Equisetum variegatum* has been documented from more northern portions of Colorado and Utah, thus might plausibly occur in Arizona.

1. Aerial stems dimorphic, the strobilus-bearing stems ephemeral, unbranched, tan to pink, the vegetative stems persisting through 1 growing season, green, with regular whorls of branches, these 3- or 4-ridged ..... ***E. arvense***

1' Aerial stems monomorphic, persisting through 1 growing season or evergreen, green, unbranched or with irregular, scattered branching in wound-forms, these with 6–20 ridges 2

2. Aerial stems evergreen, the surface somewhat roughened (sand-papery); strobili with a sharp mucro at tips ..... ***E. hyemale***

2' Aerial stems persisting through 1 growing season, the surface smooth; strobili rounded at tips ..... ***E. laevigatum***

Equisetum arvense L. (of the field). Common Horsetail, Field Horsetail (Fig. 2A). —AERIAL STEMS dimorphic, erect, the surface smooth; fertile stems 7–35 cm long, ephemeral, tan to pink, unbranched; vegetative stems 10–60 cm long, 5–14-ridged, persisting through 1 growing season, green, with regular whorls of branches, these 3- or 4-ridged. SHEATHS as long as or longer than wide, lacking bands or markings; teeth 5–14 per sheath (3–4 on branches), 1–3 mm long (-8 mm on fertile stems), mostly black, persistent. STROBILI 5–35 mm long, the tips rounded. SPORES 35–70 µm in diameter. —Wet soil of montane meadows and stream banks, less commonly on moist rock ledges: Apache, Coconino, Gila, Graham, Mohave, Navajo, Pima, Yavapai cos. (Fig. 1A); 1400–2700 m (4500–8800 ft); nearly worldwide.

The fertile stems of *E. arvense* are produced in April and May before the vegetative ones and wither soon after the spores are shed. They tend to be stouter than the vegetative stems, with fewer ridges and larger sheaths. The vegetative stems have regular whorls of branches, these with only 3–4 ridges. Care must be taken not to confuse these branches with those of wound-forms of other Arizona species, which develop following damage by flood-waters, and which occur

irregularly and generally have more ridges.

Equisetum hyemale L. (of winter). Common Scouring-rush. —AERIAL STEMS monomorphic, evergreen, 30–220 cm long, 14–50-ridged, erect (to prostrate after flooding), the surface somewhat roughened (sand-papery), usually dark green at maturity, unbranched or with irregular, scattered branches in wound-forms, these with 6–20 ridges. SHEATHS as long as or slightly shorter than wide, variously marked with a dark basal band, a light gray to brown central band, and a dark tip, sometimes more or less uniformly darkened; teeth 14–50 per sheath (6–20 on branches), 2–4 mm long, gray to black. STROBILI 8–25 mm long, the tips sharply mucronate. SPORES 35–70 µm in diameter. $2n = 216$. 2 subspp. [often treated as vars.]; N. Amer., C. Amer., Eur., Asia.

Subsp. **affine** (Engelm.) Calder & Roy L. Taylor (allied to; Figs. 2B–C). —STEMS with minute tubercles in 1 row along the ridges. TEETH irregularly persistent. [*E. hyemale* var. *affine* (Engelm.) A.A. Eaton, var. *pseudohyemale* (Farw.) C.V. Morton, var. *robustum* (A. Braun) A.A. Eaton; *E. prealtum* Raf.] —Banks of streams and rivers, marshy meadows, roadside ditches: Apache, Cochise, Coconino, Gila, Graham, Maricopa, Mohave, Navajo, Pima, Santa Cruz, and Yavapai cos. (Fig. 1B); 900–2600 m (2850–8500 ft); June–Sep; U.S., Can. Mex., Guatemala.

Equisetum ×*ferrissii* Clute [*E. hyemale* var. *elatum* (Engelm.) C.V. Morton, *E. h.* var. *intermedium* A.A. Eaton] is the hybrid between *E. hyemale* and *E. laevigatum*, which is relatively common and widespread in Arizona. It has been reported from Apache, Cochise, Coconino, Gila, Greenlee, La Paz, Mohave, Navajo, Pima, Santa Cruz, and Yavapai cos., including sites where one or both parental species are absent. It either persists after extirpation of the parents or more probably colonizes such sites vegetatively. This sterile hybrid is most easily identified by the indehiscent strobili, which may be broken open to reveal the cottony mass of elaters, but no mature, green, globose spores (the spores are white and misshapen). The morphology of the more-or-less evergreen aerial stems is quite variable, but they are generally at least slightly rough to the touch and the stem sheathes sometimes resemble those of *E. hyemale* toward the stem base and those of *E. laevigatum* toward the tip. The strobili are at least somewhat mucronate.

Equisetum laevigatum A. Braun (smooth; Fig. 2D). Smooth Scouring-rush. —AERIAL STEMS monomorphic, persisting through 1 growing season, 20–110 cm long, 10–32-ridged, erect (to prostrate after flooding), the surface smooth, usually bright green at maturity, unbranched or with irregular, scattered branches in wound-forms, these with 6–15 ridges. SHEATHS longer than wide, green with a narrow, dark tip; teeth 10–32 per sheath (6–15 on branches), 2–3 mm long, gray to black, shed early. STROBILI 8–25 mm long, the tips rounded. SPORES 35–70 µm in diameter. [*E. funstonii* A.A. Eaton, *E. kansanum* J.H. Schaffn.]. —Banks of streams and rivers, marshy meadows, wet, sandy areas: Apache, Cochise, Coconino, Gila, Greenlee, Maricopa, Mohave, Navajo, Pima, Santa Cruz, and Yavapai cos. (Fig. 1C); 1000–2600 m (3500–8400 ft); May–Aug; w U.S. e to OH, Can. n Mex.

For a discussion of the hybrid with *E. hyemale*, see the treatment of that species.

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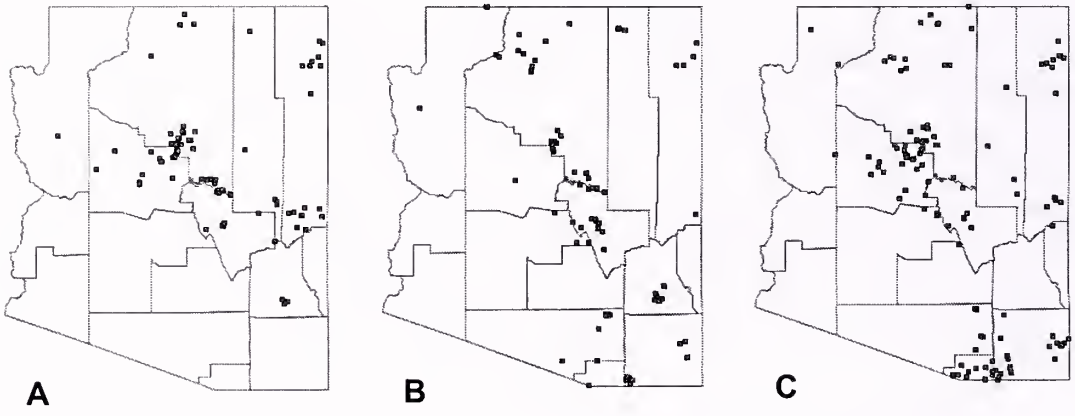
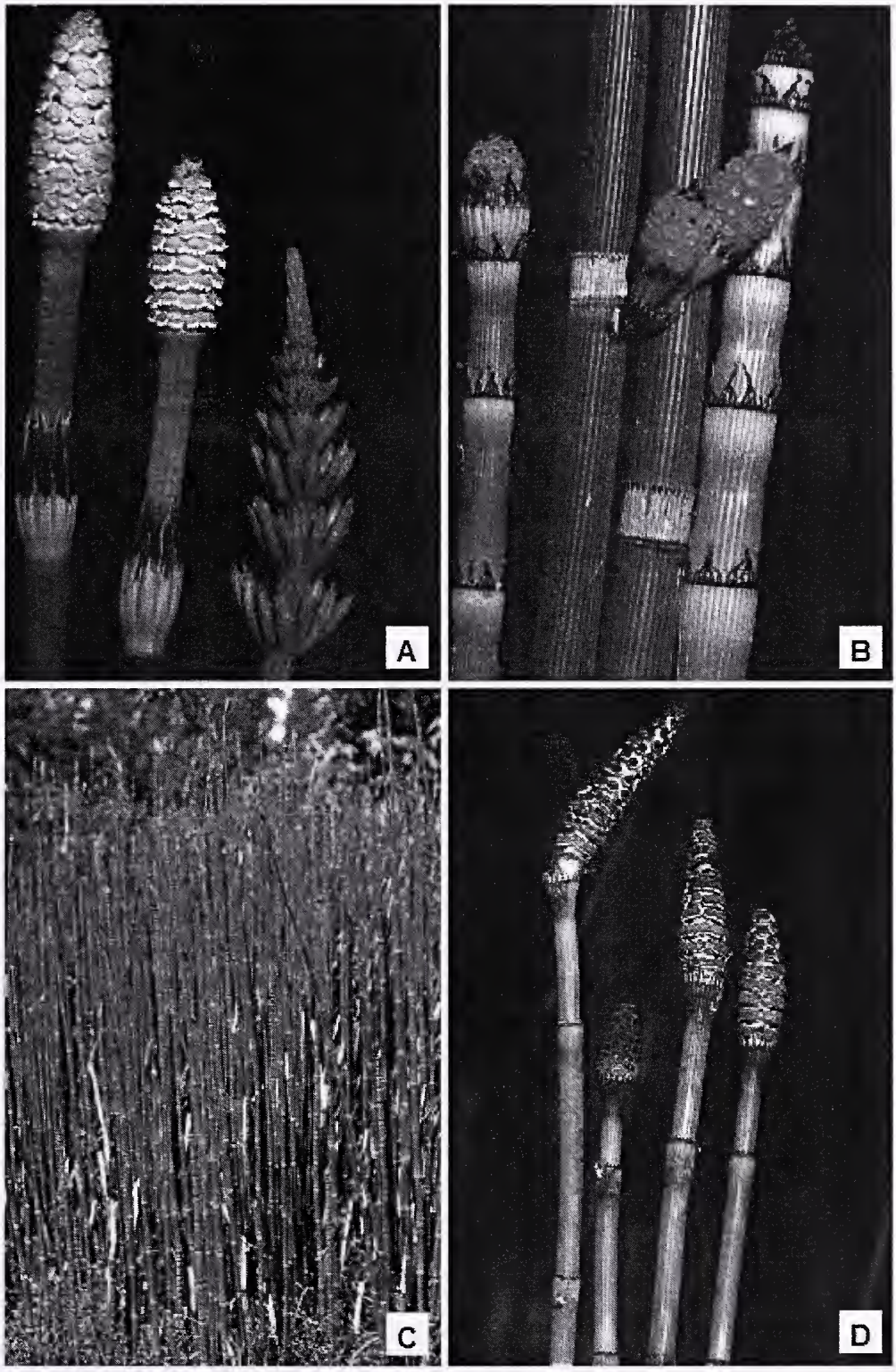


Equisetaceae Figure 1. Distributions of: (A) *Equisetum arvense*; (B) *Equisetum hyemale* subsp. *affine*; (C) *Equisetum laevigatum*.



Equisetaceae Figure 2. Comparison of species: (A) *Equisetum arvense,* close-up; (B) *Equisetum hyemale* subsp. *affine*, close-up; (C) *Equisetum hyemale* subsp. *affine*, habitat; (D) *Equisetum laevigatum*, close-up.

SALVINIACEAE FLOATING FERN FAMILY

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Annual or perennial floating aquatic herbs, sometimes stranded on mud, heterosporous. ROOTS absent. STEMS usually pinnately branched, often breaking apart with age, with multicellular hairs. LEAVES in whorls of 3 per node; dimorphic, 2 of them floating, green, the other submersed, nonphotosynthetic. FLOATING LEAVES sessile or short-petiolate, simple, the venation densely reticulate without free included veinlets, the abaxial (submersed) surface with multicellular hairs similar to those of the stem especially in the proximal portion, the adaxial (emergent) surface with dense, complex, branched multi-cellular hairs consisting of a main column (interpreted as a papilla by some authors) terminated with 4 multicellular branches. SUBMERSED LEAF short- to long-petiolate, dissected into a root-like network of fibrous veins. SORI borne in sporocarps on short stalks along the submersed leaf. SPOROCARPS of 2 types on the same plant, each consisting of sporangia enclosed in a membranous indusium, some of these with 10 or more megasporangia, each containing 1 megaspore, others with numerous microsporangia, each with 64 microspores. SPORANGIA thin-walled, lacking an annulus, breaking open irregularly through decay. SPORES trilete, globose, relatively smooth-walled, megaspores large (0.3–0.5 mm) much larger than the dust-like (18–32mm) microspores. GAMETOPHYTES reduced, developing inside the spores, the archegonia and antheridia protruding from the spore wall. X = 9. —1 genus, ca. 10 spp., mostly tropical, N. Amer. to S. Amer., Eur., Asia, Afr.

Salvinia Ség. Floating Fern, Water Spangles

Characters of the family. (for A. W. Salvini, Italian botanist).

Salvinia molesta D.S. Mitch. (burdensome or annoying). Giant Salvinia, Kariba Weed (Fig. 3). —STEMS with dense dark multicellular hairs. FLOATING LEAVES 0.8–3.0 cm long, the blade elliptic-ovate to oblong-ovate and relatively flat in young plants, oblong-ovate to suborbicular and somewhat folded along the midrib in mature plants, shallowly notched at the tip, cordate at the base, the

Vascular Plants of Arizona: Salviniaceae. *CANOTIA* 4 (2): 46–49, 2008.
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venation obscure, the adaxial trichomes to 2 mm long (Fig. 2), the 4 apical branches fused at the tip, creating the impression of an egg-beater or cage. SUBMERGED LEAVES 1.5–6.0 cm long, short-petiolate, the root-like blade with numerous branches mostly near the base, with dense dark multicellular hairs. SPOROCARPS in chain-like clusters of 6–35 along "branches" of the submerged leaf blade, the proximal 1 or 2 slightly longer-stalked and megasporangiate, the remainder microsporangiate, 1.2–2.2 mm long, ovoid, narrowed to a short beak-like tip, pubescent with hairs similar to those of the submerged leaf. SPORANGIA empty or the spores abortive and collapsed. $2n = 45$. —Backwaters of the Colorado River and canals, floating aquatic in still or slow-moving water, occasionally stranded on mud: La Paz and Yuma cos. (Fig. 1); 20–100 m (60–300 ft); native of s Brazil, naturalized in regions with warm climates nearly worldwide.

Giant Salvinia is considered one of the worst weeds in the world. Although this taxon is a sterile pentaploid of putative hybrid origin (Loyal and Grewal, 1966; Schneller, 1981), plants propagate vegetatively extremely rapidly and can cover the water's surface so densely as to exclude light and preclude gas exchange. In other parts of the world, *S. molesta* has not only wreaked havoc with the ecology of aquatic habitats, but has also had an economic impact by causing declines in fisheries, impeding traffic of small watercraft, and clogging the intakes of hydroelectric plants (see Room [1990] and Moran [1992] for reviews of the ecology and conservation biology). In the United States, infestations have been reported along the Gulf Coastal Plain from eastern Texas to Florida, and the U.S. Department of Agriculture has declared the species a federal noxious weed, prohibited from commerce and interstate transport. Despite this, Giant Salvinia continues to be one of several *Salvinia* species sold as an ornamental for aquaria and water gardens.

In Arizona, the species was first reported by Tellman (1999), based on plants observed by state and federal agency biologists in the Colorado River south of Parker. These apparently originated from plants introduced into an agricultural drainage ditch in eastern Imperial County, California, which then reproduced and were transported into the main river drainage. Concern exists about its potential spread into adjacent wildlife refuges and possible impacts on sport fishing, hydroelectric plants, and riverine ecology, but thus far eradication attempts have not been successful.

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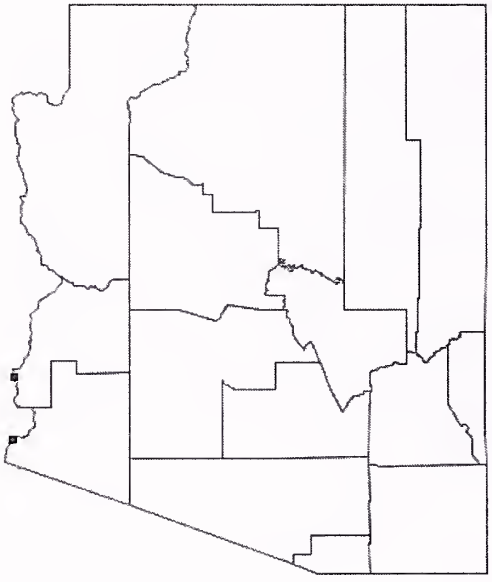

Salviniaceae Figure 1. Distribution of: *Salvinia molesta*.

Salviniaceae Figure 2. Leaves of *Salvinia molesta,* showing adaxial trichomes.

Salviniaceae Figure 3. *Salvinia molesta* plants with sporocarps.

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Index to Families of the Vascular Plants of Arizona

Bolded treatments are published in volumes 26, 27, 29, 30, 32, 33, and 35 of the *Journal of the Arizona-Nevada Academy of Science* (JANAS) or volumes 1, 2, 3, or 4 of CANOTIA. Unbolded entries indicate families with no treatments published to date. Figure numbers refer to illustrations in the "Key to Families of Vascular Plants in Arizona" in JANAS 35(2).

Acanthaceae (Fig. 3)
Aceraceae JANAS 29(1):2. 1995. (L.R. Landrum)
Adiantaceae (Fig. 1)
Agavaceae Part 1: *Agave* JANAS 32(1):1. 1999. (W. Hodgson)
Aizoaceae
Alismataceae
Amaranthaceae (Fig. 4)
Anacardiaceae CANOTIA 3(2):13. 2007. (J.L. Anderson)
Apiaceae (Fig. 5)
Apocynaceae JANAS 27(2):164. 1994. (S.P. McLaughlin)
Araceae
Araliaceae
Arecaceae JANAS 32(1):22. 1999. (C.T. Mason, Jr.)
Aristolochiaceae JANAS 32(1):24. 1999. (C.T. Mason, Jr.)
Asclepiadaceae JANAS 27(2):169. 1994. (E. Sundell)
Aspleniaceae
Asteraceae (Figs. 6–7)
Azollaceae CANOTIA 4(2):31. 2008. (G. Yatskievych and M.D. Windham)
Berberidaceae JANAS 26(1):2. 1992. (J.E. LaFerriere) (Fig. 9)
Betulaceae JANAS 33(1):1. 2001. (J.W. Brasher)
Bignoniaceae JANAS 32(1):26. 1999. (C.T. Mason, Jr.)
Bixaceae JANAS 27(2):188. 1994. (W. Hodgson)
Blechnaceae CANOTIA 4(2):35. 2008. (G. Yatskievych and M.D. Windham; Fig. 1)
Boraginaceae (Fig. 9)
Brassicaceae
Bromeliaceae CANOTIA 3(2): 23. 2007. (R. Gutierrez, Jr.)
Buddlejaceae JANAS 26(1):5. 1992. (E.M. Norman)
Burseraceae JANAS 32(1):29. 1999. (A. Salywon)
Cactaceae Part One: The Cereoid Cacti JANAS 29(1):6. 1995. (D.J. Pinkava)
Cactaceae Part Two: *Echinocactus* JANAS 29(1):13. 1995. (M. Chamberland)
Cactaceae Part Three: *Cylindropuntia* JANAS 32(1):32. 1999. (D.J. Pinkava)
Cactaceae Part Four: *Grusonia* JANAS 32(1):48. 1999. (D.J. Pinkava)
Cactaceae Part Five: *Pediocactus* and *Sclerocactus* JANAS 33(1):9. 2001. (K.D. Heil and J.M. Porter)
Cactaceae Part Six: *Opuntia* JANAS 35(2):137. 2003. (D.J. Pinkava).
Callitrichaceae JANAS 29(1):15. 1995. (J. Ricketson)
Campanulaceae
Cannabaceae JANAS 32(1):53. 1999. (C.T. Mason, Jr.)
Capparaceae (Fig. 8)
Caprifoliaceae (Fig. 10)
Caryophyllaceae (Fig. 10)
Celastraceae JANAS 30(2):57. 1998. (J.W. Brasher)
Ceratophyllaceae JANAS 29(1):17. 1995. (J. Ricketson)
Chenopodiaceae (Fig. 9)
Clusiaceae
Commelinaceae JANAS 33(1): 19. 2001. (R. Puente and R. Faden)
Convolvulaceae JANAS 30(2):61. 1998. (D.F. Austin)
Cornaceae
Crassulaceae JANAS 27(2):190. 1994. (R. Moran)
Crossosomataceae JANAS 26(1):7. 1992. (C. Mason)
Cucurbitaceae (Fig. 10)
Cupressaceae JANAS 27(2):195. 1994. (J. Bartel)
Cuscutaceae
Cyperaceae (Fig. 18)
Dennstaedtiaceae CANOTIA 4(2):38. 2008. (G. Yatskievych and M.D. Windham; Fig. 1)
Dipsaceae JANAS 27(2):201. 1994. (J.E. LaFerriere)
Dryopteridaceae (Fig. 1)
Elaeagnaceae
Elatinaceae
Ephedraceae (Fig. 2)
Ericaceae CANOTIA 4(2):21. 2008. (J.L. Anderson; Fig. 11)
Euphorbiaceae Part 1: *Acalypha* and *Cnidoscolus* JANAS 29(1):18. 1995. (G.A. Levin)
Equisetaceae CANOTIA 4(2):41. 2008. (G. Yatskievych and M.D. Windham)
Fabaceae (Figs. 12–13)
Fagaceae JANAS 27(2):203. 1994. (L.R. Landrum)
Fouquieriaceae JANAS 32(1):55. 1999. (C.T. Mason, Jr.)
Fumariaceae JANAS 33(1):27. 2001. (S. Holiday and A. Perez)
Garryaceae JANAS 33(1):31. 2001. (R. Puente and T.F. Daniel)
Gentianaceae JANAS 30(2):84. 1998. (C.T. Mason, Jr.)
Geraniaceae (Fig. 14)
Grossulariaceae
Haloragaceae
Hippuridaceae JANAS 29(1): 25. 1995. (J. Ricketson)
Hydrangeaceae
Hydrocharitaceae
Hydrophyllaceae (Fig. 14)
Iridaceae Part One: *Sisyrinchium* JANAS 27(2):215. 1994. (A.F. Cholewa and D.M. Henderson)
Iridaceae Part Two: *Iris* and *Nemastylis* JANAS 33(1):35. 2001. (C.T. Mason, Jr.)
Isoetaceae
Juglandaceae JANAS 27(2):219. 1994. (J.E. LaFerriere)
Juncaceae (Fig. 19)
Juncaginaceae
Key to Families of Vascular Plants in Arizona JANAS 35(2):88. 2003. (D.J. Keil)
Krameriaceae JANAS 32(1): 57. 1999. (B.B. Simpson and A. Salywon)
Lamiaceae Part One: *Agastache, Hyptis, Lamium, Leonurus, Marrubium, Monarda, Monardella, Nepeta, Salazaria, Stachys, Teucrium, and Trichostema* JANAS 35(2):151. 2003. (C.M. Christy, D.Z. Damrel, A. Henry, A. Trauth-Nare, R. Puente-Martinez, and G. Walters)
Lemnaceae JANAS 26(1):10. 1992. (E. Landolt)
Lennoaceae JANAS 27(2):220. 1994. (G. Yatskievych)
Lentibulariaceae
Liliaceae (Fig. 19)
Linaceae
Loasaceae JANAS 30(2): 96. 1998. (C.M. Christy)
Lythraceae
Malpighiaceae
Malvaceae Part One. all genera except *Sphaeralcea*. JANAS 27(2):222. 1994. (P.A. Fryxell)
Marsileaceae
Martyniaceae CANOTIA 3(2):26. 2007. (R. Gutierrez, Jr.)
Meliaceae
Menispermaceae JANAS 27(2):237. 1994. (J.E. LaFerriere)
Menyanthaceae JANAS 33(1):38. 2001. (C.T. Mason, Jr.)
Monotropaceae JANAS 26(1):15. 1992. (E. Haber)

Molluginaceae JANAS 30(2):112. 1998. (C.M. Christy)
Moraceae
Najadaceae
Nyctaginaceae (Fig. 14)
Nymphaeaceae JANAS 29(1): 26. 1995. (J. Ricketson)
Oleaceae (Fig. 15)
Onagraceae (Fig. 15)
Ophioglossaceae
Orchidaceae
Orobanchaceae
Oxalidaceae JANAS 30(2):115. 1998. (R. Ornduff and M. Denton)
Papaveraceae JANAS 30(2):120. 1998. (G.B. Ownbey with contributions by J.W. Brasher and C. Clark)
Passifloraceae JANAS 33(1):41. 2001. (J.M. MacDougal)
Phytolaccaceae JANAS 33(1):46. 2001. (V. Steinmann)
Pinaceae
Plantaginaceae JANAS 32(1):62. 1999. (K.D. Huisinga and T.J. Ayers)
Platanaceae JANAS 27(2):238. 1994. (J.E. LaFerriere)
Plumbaginaceae
Poaceae (Fig. 20)
Polemoniaceae CANOTIA 1:1. 2005. (D. Wilken and M. Porter)
Polygalaceae
Polygonaceae (Fig. 15)
Polypodiaceae (Fig. 1)
Pontederiaceae JANAS 30(2):133. 1998. (C.N. Horn)
Portulacaceae CANOTIA 2(1):1. 2006. (A. Bair, M. Howe, D. Roth, R. Taylor, T. Ayers, and R.W. Kiger)
Potamogetonaceae
Primulaceae JANAS 26(1):17. 1992. (A.F. Cholewa; Fig. 16)
Psilotaceae CANOTIA 3(2):32. 2007. (R. Gutierrez, Jr.)
Pyrolaceae JANAS 26(1):22. 1992. (E. Haber)
Rafflesiaceae JANAS 27(2):239. 1994. (G. Yatskievych)
Ranunculaceae (Fig.15)
Resedaceae
Rhamnaceae CANOTIA 2(1):23. 2006. (K. Christie, M. Currie, L. Smith Davis, M-E. Hill, S. Neal, and T. Ayers)
Rosaceae Part One: *Rubus*. JANAS 33(1):50. 2001. (J.W. Brasher)
Rubiaceae 29(1):29. 1995. (L. Dempster and E.T. Terrell; Fig. 16)
Ruppiaceae
Rutaceae
Salicaceae Part One. *Populus*. JANAS 26(1):29. 1992. (J.E. Eckenwalder)
Salicaceae Part Two. *Salix*. JANAS 29(1):39. 1995. (G.W. Argus)
Salviniaceae 4(2):50. 2008. (G. Yatskievych and M.D. Windham)
Santalaceae JANAS 27(2):240. 1994. (J.E. LaFerriere)
Sapindaceae JANAS 32(1):76. 1999. (A. Salywon)
Sapotaceae JANAS 26(1):34. 1992. (L.R. Landrum)
Saururaceae JANAS 32(1):83. 1999. (C.T. Mason, Jr.)
Saxifragaceae JANAS 26(1):36. 1992. (P. Elvander; Fig. 16)
Scrophulariaceae (Fig. 17)
Selaginellaceae
Simaroubaceae JANAS 32(1):85. 1999. (J.W. Brasher)
Simmondsiaceae JANAS 29(1):63. 1995. (J. Rebman)
Solanaceae Part One. *Datura*. JANAS 33(1):58. 2001. (R. Bye)
Sparganiaceae JANAS 33(1):65. 2001. (J. Ricketson)
Sterculiaceae
Tamaricaceae
Thelypteridaceae
Tiliaceae
Typhaceae JANAS 33(1):69. 2001. (J. Ricketson)
Ulmaceae JANAS 35(2):170. 2003. (J.W. Brasher)
Urticaceae JANAS 26(1):42. 1992. (D. Boufford)
Valerianaceae
Verbenaceae
Violaceae. JANAS 33(1):73. 2001. (R.J. Little; Fig. 17)
Viscaceae JANAS 27(2):241. 1994. (F.G. Hawksworth and D. Wiens)
Vitaceae
Zannichelliaceae
Zygophyllaceae (Fig. 17)